WATER ELECTROLYSIS SYSTEM

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a water electrolysis cell that produces hydrogen by electrolyzing water.

Description of the Related Art

As a water electrolysis system for producing hydrogen by electrolyzing water, a system has hitherto been known which comprises a stack of a plurality of water electrolysis cells each of which has such a configuration that a solid polyelectrolyte membrane is sandwiched by a pair of catalyst layers and a porous power feeder is laminated on each of the catalyst layers. In the above described water electrolysis system, pure water heated to the order of 80°C is supplied to the above described catalyst layers and porous power feeders of each of the water electrolysis cells, and a voltage is applied to each of the porous power feeders. In this way, oxygen and hydrogen ions are generated in the anode section of each of the water electrolysis cells where electrolysis of water as represented by the following formula (1) occurs to donate electrons to the electrode. The above described hydrogen ions move to the cathode section while penetrating through the above described solid polyelectrolyte membrane, and are given electrons from the electrode in the cathode section; consequently, hydrogen is generated in the cathode section

of each of the water electrolysis cells as represented by the following formula (2).

$$2H_2O \rightarrow O_2\uparrow + 4H^+ + 4e^- \quad \ldots (1)$$

$$2H^+ + 4e^- \rightarrow H_2\uparrow \quad \ldots (2)$$

Thus, in the above described water electrolysis system, the hydrogen generated in the above described cathode section of each of the water electrolysis cells is brought out and provided to certain prescribed applications. The above described hydrogen is utilized, for example, as fuel for fuel cells.

On the other hand, in the above described water electrolysis system, the oxygen generated in the anode section of each of the water electrolysis cells is brought out as a gas/liquid mixture of oxygen and pure water. In this context, the above described pure water is high in price, which is separated from the oxygen by means of a gas/liquid separating unit, and thus recovered and subjected to recycling (for example, see Japanese Patent Laid-Open No. 8-260176). In the above described conventional water electrolysis system, the above described gas/liquid separating unit is arranged in a manner independent of the above described water electrolysis cell stack, and is connected to the water electrolysis cell stack through piping.

In the above described conventional water electrolysis system, however, the recovered pure water cannot avoid degradation in purity as water, and hence is accompanied by a problem that the recovered pure water can hardly be subjected to recycling as it is.

SUMMARY OF THE INVENTION

The present invention takes as its object the provision of a water electrolysis system in which such a problem as described above is overcome and the recovered pure water can be easily subjected to recycling.

For the purpose of achieving the above described object, the water electrolysis system of the present invention comprises a water electrolysis system comprising a water electrolysis means that comprises a pair of catalyst layers and an electrolyte membrane sandwiched by both of the catalyst layers, electrolyzes pure water supplied to the catalyst layers, and brings out hydrogen from one catalyst layer and brings out a gas/liquid mixture of oxygen and pure water from the other catalyst layer, a gas/liquid separating means for separating pure water from the gas/liquid mixture of oxygen and pure water both brought out from said water electrolysis means, and a backflow means for making the pure water, separated by said gas/liquid separating means, flow back to the water electrolysis means, wherein the gas/liquid separating means is arranged to be directly connected to a discharge opening through which the gas/liquid mixture of oxygen and pure water is brought out from said water electrolysis means, and the gas/liquid mixture directly flows into the gas/liquid separating means through the discharge opening.

In the water electrolysis system of the present invention, the above described gas/liquid separating device is directly connected to the discharge opening through which the gas/liquid

mixture of oxygen and pure water is brought out from the above described water electrolysis device, and accordingly the above described gas/liquid mixture is made to flow from the above described discharge opening directly into the gas/liquid separating device so that it is not necessary to connect the gas/liquid separating device to the water electrolysis device through piping. Consequently, the pure water supplied to the above described water electrolysis device is made to flow directly into the gas/liquid separating device as a gas/liquid mixture of the pure water and the above described oxygen after having been subjected to electrolysis so that the temperature decrease and the purity degradation as water can be suppressed.

Thus, according to the water electrolysis system of the present invention, the recovered pure water can be easily subjected to recycling. Additionally, according to the water electrolysis system of the present invention, the temperature decrease of the recovered pure water is suppressed, and hence it is not necessary to use a heating device such as a heater for heating the pure water so that the energy efficiency can be enhanced.

Additionally, it is preferable that the water electrolysis system of the present invention comprises a purifying means for purifying with the aid of ion exchange resin the pure water made to flow back by means of the above described backflow means, and the pure water having been purified by the purifying means is made to flow back to the above described water electrolysis means. According to the water electrolysis system of the present invention, the

recovered pure water is suppressed as described above in degradation of the purity as water. Consequently, it suffices that the recovered pure water is purified by use of such a simple and easy to use means as above described ion exchange resin when the recovered pure water is made to flow back to the above described water electrolysis means by the above described backflow means, and thus the recovered pure water can easily recover the purity required for the above described electrolysis. Additionally, by adopting this way, the energy which would be required for newly producing pure water can be cut down. Making the above described purifying means be arranged adjacent to the above described water electrolysis means permits cutting down the piping, and accordingly permits suppressing the temperature decrease and degradation of purity as water of the recovered pure water.

Additionally, it is preferable that in the water electrolysis system of the present invention, the above described gas/liquid separating means comprises an intake opening for mint pure water to be supplied to the above described water electrolysis means. By adopting this way, mint pure water is supplied to the above described gas/liquid separating means from the above described intake opening, and made to merge with the above described recovered pure water within the gas/liquid separating means to be supplied to the above described water electrolysis means. Accordingly, the backflow means for the above described recovered pure water and a supply means for supplying mint pure water to the above

described water electrolysis means are made to share the same means, and the system configuration can thereby be simplified.

Additionally, it is preferable that the above described gas/liquid separating means comprises a filter for separating oxygen and pure water from each other. The above described gas/liquid separating means can efficiently separate, using a small operation volume, oxygen and pure water from each other owing to provision of the above described filter. As the above described filter, for example, a stainless-steel mesh can be used.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an illustrative sectional view of a water electrolysis system of an embodiment of the present invention; and

FIG. 2 is an enlarged illustrative sectional view of the main part of the water electrolysis system shown in FIG. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Further detailed description will be made below of an embodiment of the present invention with reference to the accompanying drawings.

The water electrolysis system of the present embodiment comprises a water electrolysis cell stack 1 and a gas/liquid separating unit 2 that is arranged in direct contact with one side face of the water electrolysis cell stack 1 without the intermediary of piping as shown in FIG. 1. The gas/liquid separating unit 2 is provided with a gas/liquid discharge

opening 3 between the water electrolysis cell stack 1 and the separating unit 2 through which a gas/liquid mixture of oxygen and pure water is brought out from the water electrolysis cell stack 1.

Additionally, the gas/liquid separating unit 2 comprises a pure water intake opening 4 for bringing in mint pure water, a filter 5 for separating the above described gas/liquid mixture into oxygen and pure water, and an oxygen discharge opening 6 for releasing the separated oxygen into the atmosphere. Incidentally, the filter 5 is made of stainless-steel mesh.

The water electrolysis system of the present embodiment further comprises a pump 8 beneath the gas/liquid separating unit 2. The pump 8 makes the pure water 7 separated from the above described gas/liquid mixture flow back to the water electrolysis cell stack 1 through a duct 8a arranged along the bottoms of the water electrolysis cell stack 1 and gas/liquid separating unit 2. Besides, a purifying unit 9 for purifying the pure water, made to flow back by the pump 8, by means of ion exchange resin is arranged adjacent to the water electrolysis cell stack 1, in a manner interposed in a midway portion of the duct 8a.

The water electrolysis cell stack 1 is provided with, on one hand, the oxygen discharge opening 3 and, on the other hand, a hydrogen discharge opening 10 for bringing out the hydrogen generated by electrolysis. Additionally, as FIG. 2 shows, the water electrolysis cell stack 1 has such a configuration that a solid polyelectrolyte membrane 11 is

sandwiched by a pair of catalyst layers 12 and 13, porous power feeders 14 and 15 are provided respectively over the catalyst layers 12 and 13, and a plurality of water electrolysis cells 16 are laminated through separators 17 which serves as a gas/liquid passage.

In the above described water electrolysis cell 16, the catalyst layers 12 and 13 are formed, for example, by screen printing a paste-like substance, obtained by dispersing a prescribed amount of a catalyst powder in an electrolyte solution that dissolves an electrolyte having the same component as the solid polyelectrolyte membrane 11, onto a sheet made of polytetrafluoroethylene. Additionally, by hot pressing under the condition that the solid polyelectrolyte membrane 11 is sandwiched with the surfaces of the above described sheet on which the catalyst layers 12 and 13 are formed, the catalyst layers 12 and 13 are transcribed respectively onto the surfaces of the solid polyelectrolyte membrane 11 and thereby bonded to the solid polyelectrolyte membrane 11.

In the next place, description will be made of the operation of the water electrolysis system of the present embodiment.

In the water electrolysis system of the present embodiment, at the beginning, mint pure water heated to the order of 80°C is supplied from the pure water intake opening 4 in the gas/liquid separating unit 2, and supplied with the aid of the pump 8 to the water electrolysis cell stack 1 through the intermediary of the purifying unit 9, and subjected to

electrolysis. Consequently, hydrogen is generated from the cathode section of each of the water electrolysis cells 16 constituting the water electrolysis cell stack 1, and brought out to the outside from the hydrogen discharge opening 10 of the water electrolysis cell stack 1. On the other hand, oxygen is generated from the anode section of each of the water electrolysis cells 16, and the oxygen forms with pure water a gas/liquid mixture, which flows from the gas/liquid discharge opening 3 directly into the gas/liquid separating unit 2.

In this context, the pure water contained in the above described gas/liquid mixture directly flows into gas/liquid separating unit 2 from the water electrolysis cell stack 1 through the gas/liquid discharge opening 3, and hence the temperature decrease scarcely occurs and the purity as water is hardly degraded.

In the next place, the above described gas/liquid mixture is separated into oxygen and pure water, by means of the filter 5 made of stainless-steel mesh in the gas/liquid separating unit 2. Then, the above described oxygen is released into the atmosphere from the oxygen discharge opening 6, while the above described pure water is stored in the gas/liquid separating unit 2 below the filter 5. Incidentally, the pure water 7 stored in the gas/liquid separating unit 2 is made to merge with mint pure water supplied from the pure water intake opening 4.

In the next place, the pure water 7 stored in the gas/liquid separating unit 2 is brought out with the aid of the pump 8 from the gas/liquid separating unit 2, transferred to the

purifying unit 9, purified with the aid of ion exchange resin and thereby recovers the purity as high as that of the mint pure water. The pure water thus purified is supplied from the purifying unit 9 to the water electrolysis cell stack 1 to be again subjected to electrolysis.

Consequently, according to the water electrolysis system of the present embodiment, the pure water recovered from the gas/liquid mixture generated in the water electrolysis cell stack 1 can be easily and effectively subjected to recycling.